REPORT NO. 83-2-5
ALEXANDRIA FIELD OFFICE

3430
NOVEMBER 1982

BIOLOGICAL EVALUATION OF INSECT DAMAGE AT THE OUACHITA SEED ORCHARD, OUACHITA NATIONAL FOREST (1982)

by

Julie C. Weatherby, Huey N. Wallace
and Sandra D. Parker[1/]

Abstract

A seed orchard scouting program consisting of 9 visits was conducted during the 1982 growing season at the Ouachita Seed Orchard, Mt. Ida, Arkansas. Approximately 39 bushels of the 1982 shortleaf cone crop and 907 bushels of the 1983 cone crop were predicted to be present in the East Ouachita seed source as of October 1982. These crop estimates represent the survival of 20% of the 1982 crop from April 1981 to October 1982 and the survival of 44% of the 1983 crop from March 1982 to October 1982. Insects were the major identifiable mortality agents causing losses to both crops. Forest Pest Management recommends that significant changes in the pest management strategy should be initiated for the 1983 growing season.

INTRODUCTION

A seed orchard scouting program was initiated during 1982. This scouting program was designed to:

1) quantify the losses attributed to the major mortality agents
2) determine the periods when major mortality occurs
3) determine the effect these losses will have on the projected cone crop
4) modify the existing pest management strategy to respond to current pest pressures.

[1/] Entomologist, Biological Technican, Biological Aid, respectively, USDA Forest Service, Southern Region, State and Private Forestry, Forest Pest Management, Pineville, LA 71360.

A scouting crew from Forest Pest Management (FPM), Alexandria Field Office, monitored damage incidences and pest populations from March to October 1982. During these visits data were compiled supporting the premise that insects are the major identifiable mortality agents causing losses in seed orchards (Overgaard et al. 1974) and, if not controlled, will adversely affect the availability of superior pine seed, thereby reducing future timber production (Barber 1982). Because a shortage in shortleaf seed from the Ouachita, Ozark, and Missouri seed sources exists, personnel from the Ouachita National Forest are interested in maximizing seed production. Based upon the results of these evaluations, Forest Pest Management recommends significant changes to the current pest management strategy.

METHODS OF EVALUATING INSECT POPULATIONS AND LOSSES

Pest management decisions are dependent upon accurate predictions and assessments of crop production levels (I), pest population levels (II), and associated damage levels (III). Three inventory-monitoring systems were implemented to quantify this information.

I. Cone and Seed Inventory-Monitoring System (Bramlett and Godbee 1982)

A. Selection of inventory trees

Sixteen clones of the East Ouachita shortleaf seed source were utilized as inventory clones. In 1981, 10 clones were selected from the high production class, 4 clones were selected from the medium production class, and 2 clones were selected from the low production class. Four ramets were sampled from each of the inventory clones. One clone from the high production class was eliminated after the 1981 season. The table below lists the selected clones, the number of ramets sampled, and the number of ramets of each clone within the E. Ouachita seed source.

Clone	Production Classes					
	High		Medium		Low	
	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)
2	4	165				
8	4	181				
11	4	150				
20	4	160				
22			4	68		
23	4	185				
28			4	163		
32					4	94
34			4	162		
38	4	152				
39					4	141
43			4	173		
46	4	164				
47	4	207				
49	4	149				
TOTAL	36	1,513	16	566	8	235

Within the high production class for the E. Ouachita seed source, 56% of the ramets are ramets of the clones inventoried. Within the medium production class, 19% of the ramets are ramets of the clones inventoried. Within the low production class, 11% of the ramets are ramets of the clones inventoried.

B. Inventory procedures

Prior to conelet closure in 1981, all of the female flowers within the tree crown were counted. This number was entered on the data sheet as a total tree count. In 1982, all the female flowers within 1/2 of the tree crown were counted. This number was doubled and entered on the data sheet as a total tree count for the 1983 cone crop.

Eight branches selected in 1981 were resampled in March, May, June, August, and October 1982, and the number of female flowers and 2nd year cones found on each tagged branch was recorded. During the first visit, new branches were selected for any missing tagged branches. If a tagged branch no longer contained any flowers or cones the tag was removed.

II. Pest Population Inventory-Monitoring System

Shortleaf pine seed orchard managers experience flower and cone losses due to several species of insect pests. The following are key insect pests causing flower, conelet, and cone damage on shortleaf pine.

Rhyacionia frustrana (Comstock)	Nantucket pine tip moth
Leptoglossus corculus (Say)	Leaffooted pine seedbug
Tetyra bipunctata (H.-S.)	Shieldbacked pine seedbug
Family Cecidomyiidae	Cone feeding midges
Dioryctria merkeli Mutuura & Munroe	Loblolly pine coneworm
Dioryctria amatella (Hulst)	Southern pine coneworm
Dioryctria clarioralis (Walker)	Blister coneworm
Eucosma cocana Kearfott	Shortleaf pine cone borer

Currently there are no techniques to predict population trends for any of these pests. A few techniques are available which can detect the presence of certain pests.

A. Pheromone trapping for Diorcytria spp.

Pheromone trapping techniques are available for 4 coneworm species, D. disclusa, D. clarioralis, D. merkeli, and D. amatella. Because pheromone trapping for these species is a relatively new technique, a standardized trapping scheme has not been developed. In the interim, Forest Service Research recommended using 10 Pherocon 1C® traps baited with each pheromone. Traps were hung with a pulley system from an upper limb located within the top 10 feet of the crown. Twice a week orchard personnel checked the traps, recording the number of male moths. Baits were changed monthly.

B. Pheromone trapping for Rhyacionia frustrana

Pheromone lures for the Nantucket pine tip moth are available commercially from Albany International. A standardized trapping scheme for shortleaf seed orchards has not been developed. However, Albany International recommended that 1 trap station should be maintained for every 2 1/2 acres. Because our scouting program did not begin until late March, we missed the emergence of the overwintering generation. Therefore, we canceled our plans to utilize pheromones for tip moth detection.

C. Visual searches for Leptoglossus corculus and Tetyra bipunctata

Attractive trapping methods are not available for either species of seedbug commonly found in seed orchards. Beginning in late March visual searches were made of all branches sampled during the cone and seed inventory-monitoring system. The number of seedbugs sighted was recorded.

III. Impact Inventory-Monitoring System

Data were gathered, which were used to generate impact estimates, by identifying causes of mortality for cones and conelets inventoried in the cone and seed inventory-monitoring system.

RESULTS AND DISCUSSION

Based upon the cone and seed inventory-monitoring system, approximately 39 bushels of cones were predicted to be present in the E. Ouachita seed source at harvest (1982). This estimate represents the survival of 20% of the original estimate made in April 1981. In addition, 907 bushels of cones (predicted 1983 crop) are currently on the trees. This estimate represents the survival of 44% of the original estimate made in March 1982. Predictions based on a generalized survival curve indicate that approximately 494 bushels of East Ouachita shortleaf cones should be harvested in October 1983. Tables 1 and 2 summarize these predictions for the 1982 and 1983 crops, respectively.

The following assumptions were used in predicting the size of the 1982 and 1983 cone crop.

1. Sample ramets are representative of all of the ramets of the selected clones.

2. Selected clones represent production levels of unsampled clones.

3. One bushel contains 1600 cones.

4. One pound of seed can be extracted from a bushel of cones.

5. Potential estimates are based on the survival of 100% of the flowers or cones from each visit until harvest.

6. Predicted estimates are based on a generalized survival curve which predicts the crop size expected at maturity when additional mortality occurs.

The orchard production in bushels of cones for the 1982 and 1983 cone crops are illustrated in figures 1A & 1B. The dashed lines on each graph represent the generalized curves compiled by Bramlett and Godbee (1982) for cone survival in a moderately managed loblolly orchard. As data become available for shortleaf cone survival, a generalized curve will be developed which will more accurately describe survival in shortleaf seed sources. The solid lines represent the actual cone survival based upon periodic observations of tagged branches.

Table 1. Estimation, based on the inventory-monitoring system, of 1982 E. Ouachita shortleaf cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
April 1981			
Potential	306,151	191	191
Predicted	196,515	123	123
July 1981			
Potential	286,670	179	179
Predicted	206,023	129	129
October 1981			
Potential	200,864	126	126
Predicted	136,292	85	85
March 1982			
Potential	160,222	100	100
Predicted	101,427	63	63
May 1982			
Potential	138,239	86	86
Predicted	91,918	57	57
June 1982			
Potential	85,173	53	53
Predicted	44,374	28	28
August 1982			
Potential	69,566	43	43
Predicted	38,400	24	24
October 1982			
Potential	62,097	39	39
Predicted	62,097	39	39

Table 2. Estimation, based on the inventory-monitoring system, of 1983 E. Ouachita shortleaf cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
March 1982			
Potential	3,292,101	2,058	2,058
Predicted	1,975,261	1,235	1,235
May 1982			
Potential	2,052,000	1,282	1,282
Predicted	888,867	555	555
June 1982			
Potential	1,801,875	1,126	1,126
Predicted	823,025	514	514
August 1982			
Potential	1,670,704	1,044	1,044
Predicted	856,128	535	535
October 1982			
Potential	1,451,010	907	907
Predicted	790,400	494	494

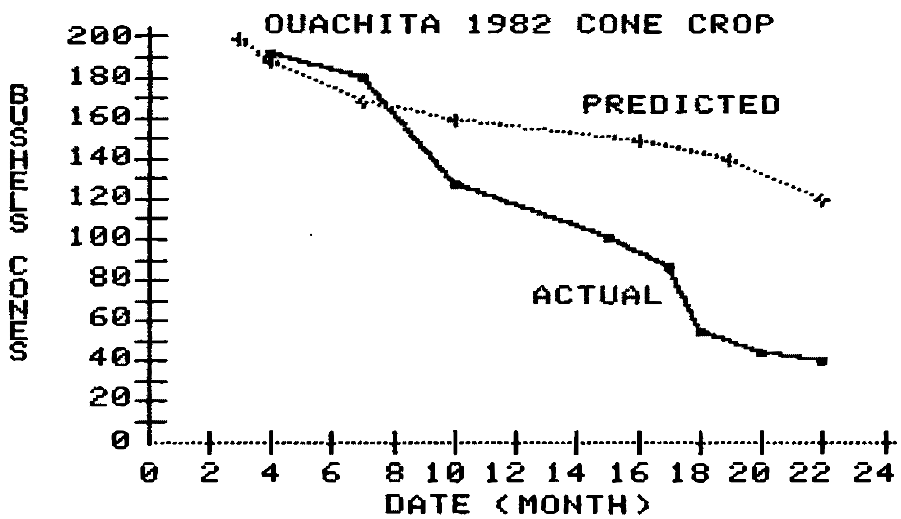

Figure 1A. Survival curve of the 1982 cone crop estimated from the cone and seed inventory-monitoring system.

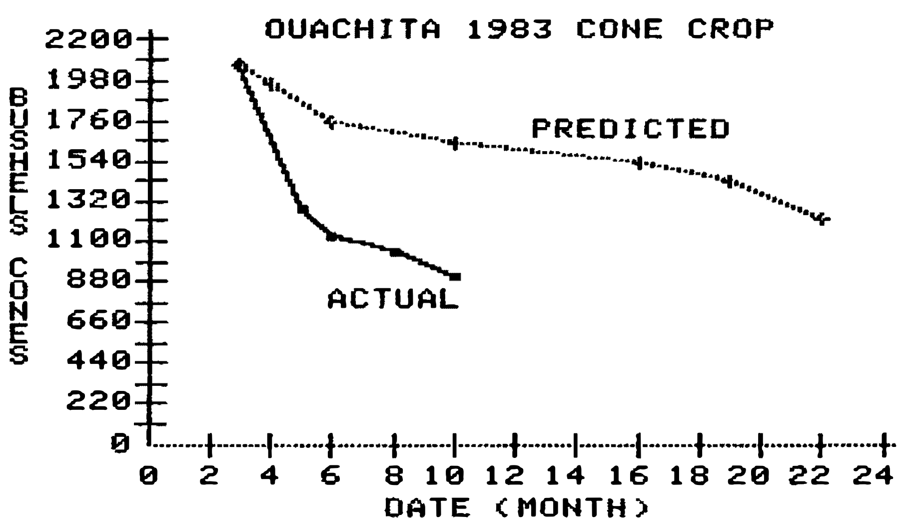

Figure 1B. Survival curve of the 1983 cone crop estimated from the cone and seed inventory-monitoring system.

Assessment of Key Pest Populations and Impact

A. Tip moths

Species - *Rhyacionia frustrana* (Comstock) - Nantucket pine tip moth

Pest Status - Tip moths are usually considered pests of young pine plantations. However, the Ouachita Seed Orchard has historically had significant losses from this pest (Overgaard 1981). This pest overwinters as a pupa, emerging in early spring prior to pollination. The adults lay eggs on shoots or conelets and hatching larvae often feed on conelets before entering shoots where they complete their development. Often several conelets in a cluster will be lost or the entire tip may die, killing the developing flowers. Tip moths have several generations per year. Apparently at the Ouachita there are 3 distinct generations.

Adult tip moths which had overwintered as pupae in dead shoots emerged prior to our initial visit on March 22, 1982. At this time, a survey of the number of previously infested tips was not taken, but it appeared that the overwintering generation was large enough to produce a first generation with a potential to cause significant losses. The impact inventory-monitoring system documented that 7.49% of the flowers existing in March had been lost to tip moths by the May inventory (table 3). This loss represents a decrease of 154 bushels from the potential 1983 cone crop. In addition, some of the missing conelets probably fell off the trees after dying from tip moth feeding. Between the May and June inventories, tip moth caused mortality dropped to 0.11%, the equivalent of 1.40 bushels (table 3). Additional losses (.95 bushels) were not attributed to tips moths until the October inventory (table 3).

During 1982 the most significant impact associated with tip moth feeding is the reduction in the number of flower bearing tips for 1983. Between the August and October inventories, the 3rd generation larvae killed as many as 90% of the tips on susceptible clones. The flower primordia on these dead and dying tips will not develop, virtually eliminating the 1984 cone crop.

Table 3. Summary of conelet mortality of the the 1983 E. Ouachita shortleaf cone crop.

Mortality Agents	No. of Dead Conelets		% Mortality	
March - May 1982				
Missing	624,265		18.96	
Tip Moth	246,737		7.49	
Unknown	223,793		6.80	
Abortion	80,890		2.46	
Unknown Insects	29,804		0.91	
TOTAL	1,205,489		36.62	
May - June 1982				
Missing	197,632		9.63	
Unknown	27,176		1.32	
Coneworms	8,279		0.40	
D. clarioralis		3,525		0.17
Shoot Attacks		2,411		0.12
Tip Moth	2,248		0.11	
Unknown Insects	1,527		0.07	
Midge	1,316		0.06	
TOTAL	238,178		11.59	
June - August 1982				
Missing	92,250		5.12	
Unknown	38,924		2.16	
Coneworms	2,933		0.16	
D. clarioralis		776		0.04
Man	2,795		0.16	
TOTAL	136,902		7.60	
August - October 1982				
Missing	144,850		8.67	
Unknown	69,698		4.17	
Tip Moth	1,516		.09	
Coneworms	2,561		.15	
TOTAL	218,625		13.08	

B. Coneworms

Species - *Dioryctria clarioralis* - blister coneworm
D. amatella - southern pine coneworm
D. merkeli - loblolly pine coneworm

Pest Status - On shortleaf, shoot attacks may be the earliest visible coneworm damage found during the spring. These attacks are usually attributed to *D. merkeli*, the loblolly pine coneworm, which has only 1 generation a year. After overwintering as small larvae, they move from shoots and flowers to cones. None of the coneworm caused mortality was directly attributed to *D. merkeli*. However, shoot attacks were occurring between the May and June evaluations (table 3). Fall pheromone trapping for *D. merkeli* indicated that a population was present in the orchard (figure 2). The adult *D. merkeli* flight began on September 2 and lasted until October 18 when a total of 31 males were trapped in 10 traps.

Dioryctria clarioralis, the blister coneworm, overwinters as a large larva and does little or no damage prior to pupating in the spring. Blister coneworm adults usually emerge during April and May. Eggs are oviposited soon after emergence and the hatching larvae seem to prefer enlarging cones. Subsequent generations prefer rapidly growing shoots and conelets. Conelet mortality (0.17%) caused by *D. clarioralis* began to occur between the May and June inventories (table 3).

Based on the pheromone trap catches (figure 2), it appears that *D. clarioralis* is the most prevalent species. The majority of the coneworm damage (12.00% in June, 17.38% in August, 2.21% in October) is not typical of *D. clarioralis* damage (table 4). Because of the relatively large *D. clarioralis* trap catches between May 10 and May 24 (figure 2), it is suspected that some of the damage is probably *D. clarioralis* damage which is not exhibiting the typical pitch blisters.

Based on the pheromone trap catches, *D. amatella* should not be causing significant losses. Questions still exist on the sensitivity of the *D. amatella* pheromone, but it appears that this species was not a major pest during 1982.

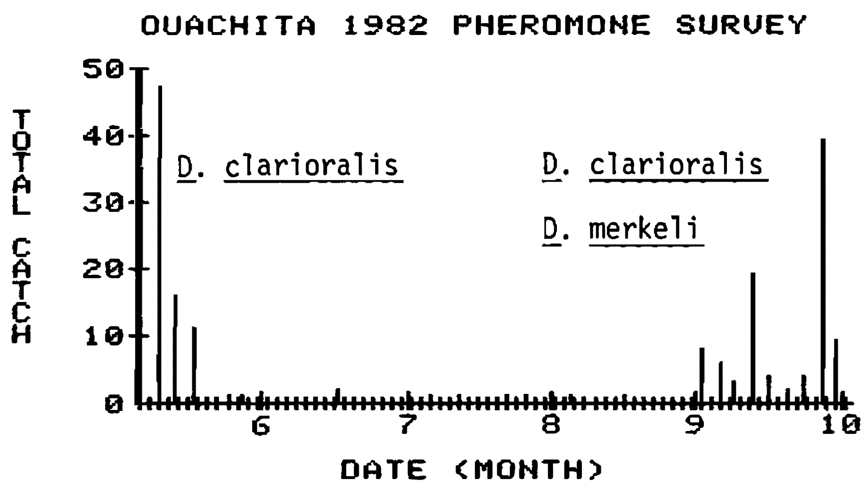

Figure 2. Frequency histogram of the pheromone trap catches of 4 coneworm species (1982).

C. Other Pests

Approximately 662 potential bushels of 1983 cones were recorded as missing with an additional 225 potential bushels of 1983 cones lost to unknown causes (table 3). It is suspected that seedbugs probably contribute to this loss. In May (1983) only adult seedbugs were sighted in the orchard. Both nymphs and adults were present from June through October. Sightings were twice as frequent in October as compared with May and June. Seedbugs were observed on approximately 4% of the branches inventoried in August.

In early spring and late fall a significant number of cones are reported to have died from unknown causes (table 4). Often midges were present on these dead cones.

RECOMMENDATIONS

Tip moths have virtually eliminated the 1983 flower crop. Therefore, pest management strategies for FY 83 should feature the 1983 cone crop. The insect caused cone losses apparently begin in May or June, peak between June and August, and decline between August and October. It appears that key insect species are causing damage to cones throughout the summer.

The pest management strategies should also be directed at suppressing tip moth population buildups. If last generation tip moth populations in 1983 build to levels experienced in 1982, the 1984 flower crop could also be destroyed.

In order to protect the 1983 cone crop and the 1984 flower crop, FPM recommends using Furadan® combined with supplementary sprays, Alternative 5 (Appendix I), as the pest management strategy for FY 83. In order to improve the benefit:cost of this alternative, FPM recommends that the Ouachita Orchard consider intensive management of portions of the orchard which have historically produced the best crops. By reducing the number of treated acres, orchard personnel should be able to insure that the Furadan application (4 oz. of Furadan 10G/inch of DBH) is applied by mid February. Assuming that uptake and translocation of Furadan is adequate, the 1st generation tip moth population should be suppressed. Because Furadan is often ineffective against coneworm populations, a series of foliar sprays (3 - 4 sprays) should be applied.

Figure 3 superimposes the suggested spray application dates on the 1982 pheromone survey histogram. The following calendar lists an approximate spray schedule.

Application	Date
1	6 days after peak pollen flight
2	mid May
3	mid June
4	early-mid September

Table 4. Summary of cone mortality of the 1982 E. Ouachita shortleaf cone crop.

Mortality Agents	No. of Dead Cones		% Mortality	
March - May 1982				
Unknown	15,671		9.78	
Missing	3,623		2.26	
TOTAL	19,294		12.04	
May - June 1982				
Coneworms	16,591		12.00	
D. clarioralis		1,381		1.00
Unknown	3,091		2.24	
TOTAL	19,682		14.24	
June - August 1982				
Coneworms	14,804		17.38	
Coneworm Damage		5,081		5.97
D. clarioralis		286		0.34
Unknown	1,052		1.24	
Unknown Damage	688		0.81	
Unknown Insect Damage	173		0.20	
TOTAL	16,717		19.63	
August - October 1982				
Missing	616		.89	
Unknown	4,386		6.30	
Unknown Damage	1,445		2.08	
Coneworms	1,538		2.21	
Coneworm Damage		1,102		1.58
TOTAL	7,985		11.48	

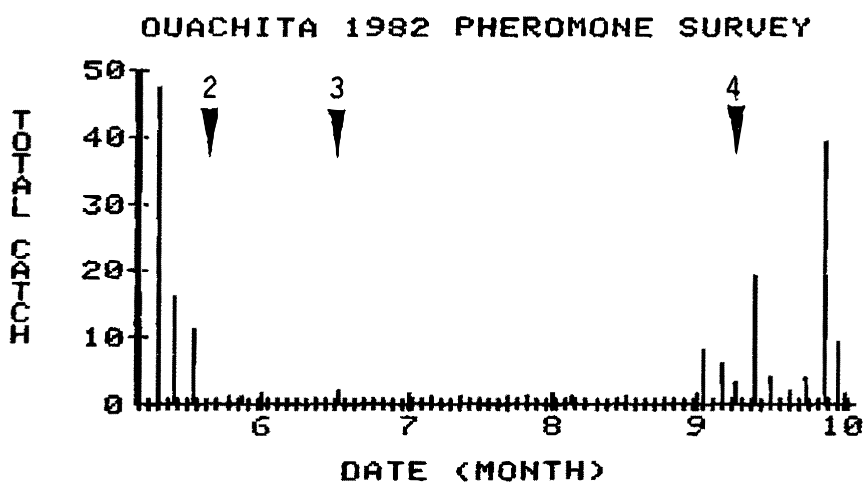

Figure 3. Frequency histogram of the pheromone trap catches with suggested pesticide application dates (◄).

If pest populations are low during mid summer, the mid June application could be eliminated. FPM will continue to assist seed orchard personnel in monitoring damage levels, particularly in late May and early June. If cone losses during this period exceed 10%, then spray 3 will be recommended strongly. If losses are less than 10%, FPM will recommend that spray 4 be eliminated.

FPM is recommending that Guthion® 2S be applied at a rate of 2 lbs. of active ingredient per acre by aircraft. Suggested application parameters for fixed-wing and helicopter are listed below.

Parameter	Helicopter	Fixed Wing
Droplet size VMD (microns)	300-350	300-350
Nozzles	50 (D-02-25)	30 (D-06-46)
Boom Pressure (PSIG)	40	40
Speed (MPH)	25	90
Swath Width (ft.)	30	30
Release height above trees (ft.)	5	5
Adjuvant - Nalco-Trol®	3 oz/100 gal H_2O	3 oz/100 gal H_2O

Our experience has shown that many aerial applicators can apply the insecticide with a 60 ft. swath. We have no reason to suspect that an increase in swath width should adversely affect the coverage. With aerial application, approximately 1/3 to 1/2 the active ingredient is applied as compared to a mistblower. The savings in chemical could help defray additional application costs.

If the Ouachita Orchard finds that Alternative 5 with aerial application does not meet their needs, FPM recommends the following alternatives in the order listed.

1) Alternative 5 - Replacing aerial with mistblower application
2) Alternative 4 - Aerial application
3) Alternative 4 - Ground application

Appendix I describes suggested control alternatives.

APPENDIX I

SEED ORCHARD PEST MANAGEMENT CONTROL ALTERNATIVES

Alternative 1. No action.

Benefits:

1) Lowers management costs
2) Encourages the natural buildup of beneficial insects and other predators
3) Reduces exposure of personnel to pesticides
4) Discourages the development of resistant strains of pests

Detriments:

1) Losses must be tolerated for indefinite periods of time
2) Pest populations may build to levels which cannot be tolerated before beneficials check the increase

Rationale: This alternative is usually selected when the value of the existing crop is less than the cost of the most inexpensive chemical control measure. As second generation orchards begin producing and as superior seed becomes available in storage, 1st generation orchards, or blocks within these orchards, may be placed on low maintenance. Under a low maintenance program, the "No Action" alternative will become an integral component.

Currently this option is of limited value. Young orchards which have not experienced pest population buildups are probably more efficiently managed without a structured spray program. Very few managers of producing orchards consider this a viable alternative.

Alternative 2. One Furadan® application.

Benefits:

1) Targeted at pests which feed on pine, not at beneficial insects
2) One application may reduce pest populations for several months

Detriments:

1) Furadan 10G has a high oral toxicity and must be incorporated into soil
2) High cost for a single application
3) Translocation is dependent upon adequate soil moisture
4) Efficacy decreases by mid summer
5) Application must be made in late winter or early spring when the ground is frozen or wet

Rationale: This alternative is usually considered for fairly well-drained orchards. Many orchards across the Southeast are too wet in late winter, and the application must be delayed. Applications made after mid February will not effectively control early season pests. Apparently Furadan provides better protection of conelet crops than it does cone crops. If the flower crop is the featured crop, then a single Furadan application may be an effective strategy.

Orchard managers who have chosen this single application strategy must be willing to accept late season losses.

<u>Alternative 3.</u> Split Furadan application.

Benefits:

1) Targeted at pests which feed on pine, not at beneficial insects
2) One application may reduce pest populations for several months
3) Allows for flexibility in determining when Furadan will be effective

Detriments:

1) Furadan 10G has a high oral toxicity and must be incorporated into soil
2) High application and chemical cost
3) Translocation is dependent upon adequate soil moisture
4) Applications may be delayed because of ground conditions

Rationale: This alternative is usually considered in the same orchard where a single Furadan application would be effective. The treatments should be made approximately 6 weeks before the targeted pests are active or before the previous Furadan concentrations have dropped below the lethal concentration (LC). This alternative may allow you to extend the protection associated with Furadan throughout the growing season. In theory, this alternative has potential. However, the

inconsistencies associated with Furadan uptake and translocation probably will make the double application even more inconsistent.

Timing is an important consideration. If the first application is targeted for early season pests, then the standard mid February application will probably be timely for this first application. Furadan usually dissipates by mid to late summer. Therefore, a second application should be applied in late May or early June.

The 2nd important consideration is the application rate. The current label allows for application of from 4-8 oz. of Furadan 10G for each inch of tree diameter. In a split application, two 4 oz. applications should be effective if uptake is sufficient.

Preliminary results indicate that split applications of Furadan used alone do not adequately increase protection over a single application (Overgaard 1976). Additional modifications could be considered but the most important consideration is the benefit:cost of 2 applications as opposed to a single application.

Alternative 4. Three to six sprays of Guthion® or Pydrin®.

Benefits:

1) Multiple sprays allow flexibility in timing applications
2) Frequency of applications can reflect insect damages and/or population levels
3) Flexibility in method of application (ground, air)

Detriments:

1) Labor intensive
2) Excessive exposure of personnel to restricted use pesticide
3) Ground applications may be delayed by excessive soil moisture
4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative allows more responsiveness to insect population levels and flexibility in targeting an application to coincide with the life cycle of the pests. Guthion and Pydrin are the only chemicals currently registered for coneworm control which can be applied monthly, throughout the summer, at the recommended rates. The most widely used formulation of Guthion is the 2S formulation. The 2S formulation does not crystalize when stored below freezing. In addition, the 2S

formulation as compared with the WP formulation can be applied with less wear to spraying equipment. However, the WP formulation has a longer residual than the 2S formulation. It may be advantageous to utilize the advantages of each formulation and use the WP formulation in spring when rainfall is heavy, switching to the less abrasive formulation in the summer and fall. Pydrin is a synthetic pyrethroid with a low mammalian toxicity. Exposure of orchard personnel to Pydrin is much less hazardous. In addition, Pydrin remains at effective concentration for longer periods than Guthion 2S.

The application schedule is extremely important. Applications should be made just prior to the periods when the greatest damages occur. The first spring application usually is made during the week following pollination. This application coincides well with the period when major conelet losses occur and when early coneworm caused losses are beginning. Subsequent sprays are often applied at monthly intervals following the initial spray. If the orchard manager has adequate information to identify and monitor the key pests, then the applications can be targeted for the suspectible stages of the key pests. Currently the technology to monitor and time sprays is limited.

Alternative 5. Furadan combined with supplementary sprays.

Benefits:

1) Insures the orchard is protected during the entire season
2) Increases the suppression efforts against coneworms
3) Early spray applications serve as a backup to Furadan if uptake is minimal

Detriments:

1) Furadan 10G has a high oral toxicity and must be incorporated into soil
2) Translocation is dependent upon adequate soil moisture
3) Application must be made in late winter or early spring when the ground is frozen or wet
4) Labor intensive
5) Ground applications may be delayed by excessive soil moisture
6) Pest management costs are increased substantially
7) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is becoming increasingly popular with industrial orchards. Often the size of the area to be treated is the limiting factor.

If Furadan uptake is sufficient, conelet survival is increased substantially. The highest Furadan concentrations are usually found in the actively growing shoots, making Furadan an ideal pesticide for early season shoot infesting pests such as tip moths. Furadan appears to be less effective against coneworms, damaging 2nd year cones. Therefore, backup sprays increase the suppression efforts targeted for coneworm control. Both pesticides are usually effective against seedbugs.

The major concern when choosing this alternative is timing the supplementary sprays to obtain maximum protection for the increased management costs. If the orchard has a history of early season pests, particularly 1st generation coneworms (Dioryctria disclusa), etc.), it may be desirable to apply a pesticide 6 days after peak pollen flight. Beginning in mid May or early June, 2 to 4 additional sprays should protect 2nd year cones against increasing coneworm populations. If cones are harvested using the traditional hand picking procedures, the last spray would probably be applied 2 or 3 weeks before harvest. If netting is used to harvest seed, the last spray can be delayed to suppress increasing populations of both seedbugs and coneworms.

The choice of insecticides is limited. Currently 2 insecticides, Pydrin and Guthion, are registered for coneworm and seedbug control. Pydrin is an ideal chemical for spray applications during periods when orchard personnel are active within the orchard and during periods when a longer residual is needed. Therefore, spring and fall would be ideal times for Pydrin applications while Guthion might be applied in mid summer. This combination of insecticides; Furadan, Guthion, and Pydrin should help eliminate many of the sucking insect problems associated with the use of Pydrin and Guthion applied by aerial application.

Alternative 6. Three to six sprays of mixed chemicals.

Benefits:

1) Multiple sprays allow flexibility in timing applications
2) Frequency of applications can reflect insect damages and/or population levels
3) Flexibility in method of application (ground, air)
4) Decreased potential for resistant pest populations
5) Less exposure to highly toxic chemicals

Detriments:

1) Labor intensive
2) Excessive exposure of personnel to restricted use pesticide

3) Ground application may be delayed by excessive soil moisture
4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is very similar to Alternative 4. It is usually advantageous to alternate chemicals rather than to depend on one chemical. Alternate applications of chemicals with different modes of actions, tend to decrease the development of resistant pest populations. Currently, Pydrin and Guthion are the two registered chemicals which fit well into a spray schedule. Hydraulic, mist blower, and aerial applications of both chemicals have been demonstrated to effectively suppress coneworm and seedbug populations. The characteristics of each chemical have been described under the rationale section of Alternative 5. These characteristics should help determine when each chemical should be applied.

PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in their original containers under lock and key out of reach of children and animals, and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear appropriate protective clothing.

If your hands become contaminated with a pesticide, wash them immediately with soap and water. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove the clothing immediately and wash skin thoroughly. After handling or spraying pesticides, do not eat or drink until you have washed with soap and water.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your county agent, state extension specialist or FPM to be sure it is still registered for the intended use. For further information or assistance, contact Forest Pest Management, Alexandria Field Office, Pineville, La., 71360, (Telephone: FTS 497-7280, or Commercial 318/473-7280).

REFERENCES

Barber, L. R. An evaluation of insect damage in three southern federal seed orchards (1982). Rep. No. SA 82-1-21. Pineville, LA: U.S. Department of Agriculture, Forest Service, Forest Pest Management; 1982.

Bramlett, D. L.; Godbee, J. F., Jr. Inventory-monitoring system for southern pine seed orchards. Gerorgia Forest Research Paper #28, Georgia Forestry Commission.

Overgaard, N. A. Monitoring of seed and cone insect damage to shortleaf pine at the Ouachita Seed Orchard, Mt. Ida, Arkansas (1974-1978). Rep. No. SA 82-2-3. Pineville, LA: U.S. Department of Agriculture, Forest Service, Forest Pest Management; 1981. 17 p.

Overgaard, N. A.; Flavell, T. H.; Drake, L. E. Seed orchard pest management in the south -- a problem analysis. U.S. Department of Agriculture, Forest Service, Southeastern Area, Forest Pest Management Group; 1974. 20 p.

Overgaard, N. A.; Wallace, H. N.; Hertel, G. D.; Stein, C.; Drake, L. E. Incidence of the Nantucket pine tip moth on shortleaf and loblolly pines in seed orchards treated with Furadan®, Cygon®, Di-Syston®, and fertilizers. Rep. No. SA 76-2-14. Pineville, LA; U.S. Department of Agriculture, Forest Service, Forest Pest Management Group; 1976. 33 p.